

Statistical Basket Pairs Trading Strategy

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Executive Summary

- Long/short sector basket strategy exploiting volatility spread mean-reversion
- Backtested across 4 thematic pairs (2015–2024)
- Market-neutral design → low correlation to SPY
- Machine Learning filter tested to improve signal quality
- Strategy shows mixed results — some pairs profitable, others not
- Strong statistical foundation but real-world alpha is elusive

Economic Rationale

Why should this work?

- Idea:
 - Within a sector, similar companies should have similar volatilities over time
- Opportunity:
 - When one basket becomes abnormally more volatile than another, that spread tends to revert to the mean
- What we are betting on:
 - Temporary dislocations in relative volatility
 - Mean-reversion within 30-60 trading days

Basket Construction

Pair	Long Basket	Short Basket
Semiconductors	ASML, TSM, KLAC	AMD, NVDA, AVGO
Energy	XOM, CVX, COP	VLO, MPC, PSX
Tech Broad vs Mega	RSPT, SOXX	QQQ, AAPL, META
Staples vs Discretionary	XLP	XLY

- Equal-weighted within each basket
- Pairs chosen for economic linkage (same sector, different sub-industries)
- Long leg = typically more stable / Short leg = typically more volatile

Signal Generation

Step 1: Calculate 20-day rolling volatility for each basket

Step 2: Compute volatility spread = Long Vol – Short Vol

Step 3: Z-score the spread using 120-day rolling mean & std

Entry Rules:

- Z-score $> +2 \rightarrow$ short the spread
- Z-score $< -2 \rightarrow$ long the spread
- VIX $> 30 \rightarrow$ stay out

Exit Rules:

- $|Z\text{-score}| < 0.5$
- Z blows out, $> \pm 3.5$
- Losing trade, down 7%+
- Market Panic VIX > 30

Backtest Performance

- Mixed Results → no clear winner
- Large drawdowns across all pairs

Pair	Sharpe	Sortino	Max Drawdown
Semiconductors	-0.19	-0.25	-50%
Energy	+0.01	+0.01	-50%
Tech vs Mega	+0.18	+0.24	-26%
Staples vs Discr.	-0.34	-0.45	-43%

Risk & Tail Behavior

- Persistent max drawdowns of 26-50%
- Some underwater for multiple years
- Worst Daily Loss (99%) → -2% to -3% loss in value
- **Bottom Line: Strategy has fat tails → big losses happen**

Yearly Excess Returns vs SPY

- Found trend where strategy outperforms when SPY is down (2018, 2022)
- Underperforms in bull markets

Year	Strategy	SPY	Better?
2018	+13%	-4%	✓
2022	+16%	-18%	✓
2020	-40%	+18%	✗
2021	-25%	+29%	✗

Cross-correlation & Regime Behavior

- Long baskets: 60-80% correlated
- Short baskets: 60–90% correlated
- Between baskets: 40–70% correlated

VIX Level	Strategy
Low (<15)	Few signals
Normal (15–25)	Best performance
High (>30)	Exit all (stop-loss)

Fixes & Improvements

Fixes:

- Removed lookahead bias
- Added train/test split
- Simplified ML to 8 features
- Added 3 stop-loss conditions

Future Improvements:

- Try price-based signals instead of volatility
- Test different sector pairs
- Use dynamic hedge ratios

Conclusion & Final Thoughts

- What Worked
 - Clean systematic approach
 - Market-neutral (low SPY correlation)
 - Stop-losses limit worst outcomes
- What Didn't
 - No consistent alpha
 - Big drawdowns
 - Underperforms in bull markets
- Final Thought
 - Proper framework, proper risk controls, but alpha is hard to find.

Questions?